

Claims

We claim:

- 1 1. A method for scheduling packets in a router of a packet-switched network
2 having a plurality of service classes, the router including one queue for each
3 service class, each queue storing packets to be transmitted according to the
4 associated service class, comprising:
5 measuring an average queue length for a particular one of the queues;
6 and
7 allocating bandwidth to each of the plurality of service classes
8 according to the average queue length.
- 1 2. The method of claim 1 wherein the plurality of services classes include a
2 premium service, an assured service, and a best-effort service, and wherein
3 the particular queue is associated with the premium service class.
- 1 3. The method of claim 1 wherein the average is an exponential weighted
2 moving average.
- 1 4. The method of claim 3 further comprising:
2 applying a low-pass filter to the an exponential weighted moving average.
- 1 5. The method of claim 1 wherein the average queue length is measured
2 every time one packet is stored in the particular queue.

1 6. The method of claim 1 wherein avg is the average queue length, and l is
2 an instantaneous queue length, and f_l is a low-pass filter, and wherein the
3 average queue length is determined by $avg \leftarrow (1 - f_l) \cdot avg + f_l \cdot l$.

1 7. The method of claim 6 wherein f_l is 0.01.

1 8. The method of claim 1 wherein the particular queue includes a minimum
2 threshold and a maximum threshold, the maximum threshold representing a
3 desired transmission delay, and the maximum threshold representing an
4 acceptable transmission delay.

1 9. The method of claim 8 wherein bandwidth for the service class associated
2 with the particular queue is increased when the average exceeds the
3 minimum threshold.

1 10. The method of claim 9 wherein the bandwidth allocated to the service
2 class remains below a predetermined upper limit when the average exceeds
3 the maximum threshold.

1 11. The method of claim 1 wherein the plurality of services classes include a
2 premium service EF , and wherein the particular queue is associated with the
3 premium service class, and wherein the particular queue includes a
4 minimum threshold T_{min} and a maximum threshold T_{max} , the maximum
5 threshold representing a desired transmission delay, and the maximum
6 threshold representing an acceptable transmission delay, and wherein avg is
7 the average queue length, and l is an instantaneous queue length, and f_l is a
8 low-pass filter, and wherein an initial weight of bandwidth for the premium

9 service is w_p , and an allocated bandwidth weight EF_w of the premium
10 service, as a function of avg is

$$11 \quad EF_w = \begin{cases} w_p, & avg \in [0, 0.5) \\ \frac{(upper - w_p) \cdot (avg - T_{\min})}{T_{\max} - T_{\min}}, & avg \in [0.5, 2) \\ upper, & avg \in [2, s) \end{cases}$$

12 where $upper$ represents a predetermined upper limit when the average
13 exceeds the maximum threshold, and s is a size of the particular queue
14 measured in packets.

1 12. The method of claim 11 where $upper$ is 0.7.

1 13. A method for scheduling packets in a router of a packet-switched
2 network having a plurality of service classes, the router including one queue
3 for each service class, each queue storing packets to be transmitted
4 according to the associated service class, comprising:
5 measuring an exponential weighted moving average queue length for
6 a particular one of the queues; and
7 allocating more bandwidth to the service class associated with the
8 particular queue if the average exceeds a predetermined minimum threshold.